



Precise Bottleneck Identification and Prioritization

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FEDERAL HIGHWAY ADMINISTRATION

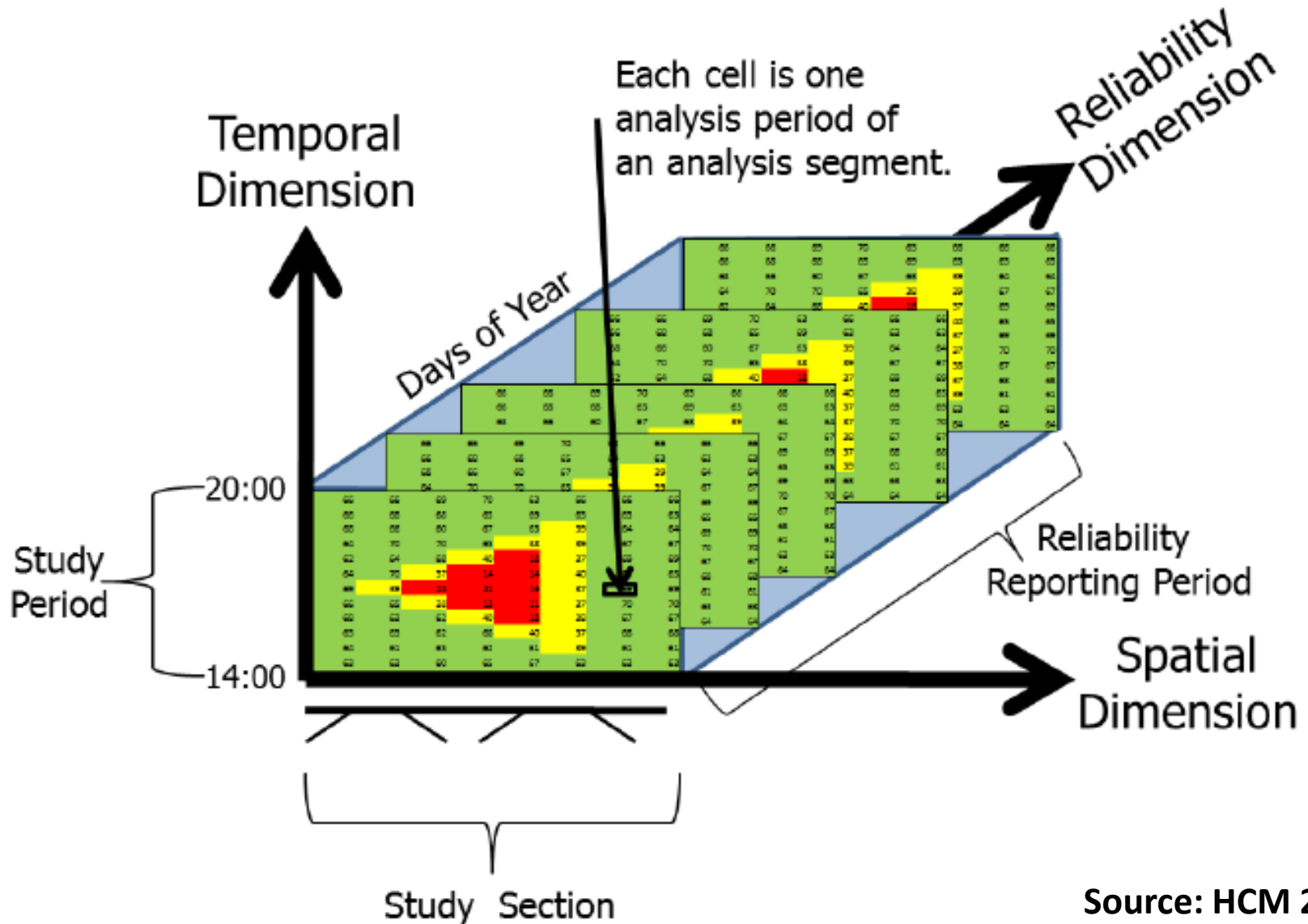


Problem Statement



- Status quo methods are limited, outdated
 - Experience and judgment (not precise or scientific)
 - Peak-hour modeling (circa 1990's)
 - Annual reliability modeling (data hungry, not cost-effective)
 - Data-driven measurements (don't emphasize reliability)

Spatiotemporal Traffic Matrix (STM)

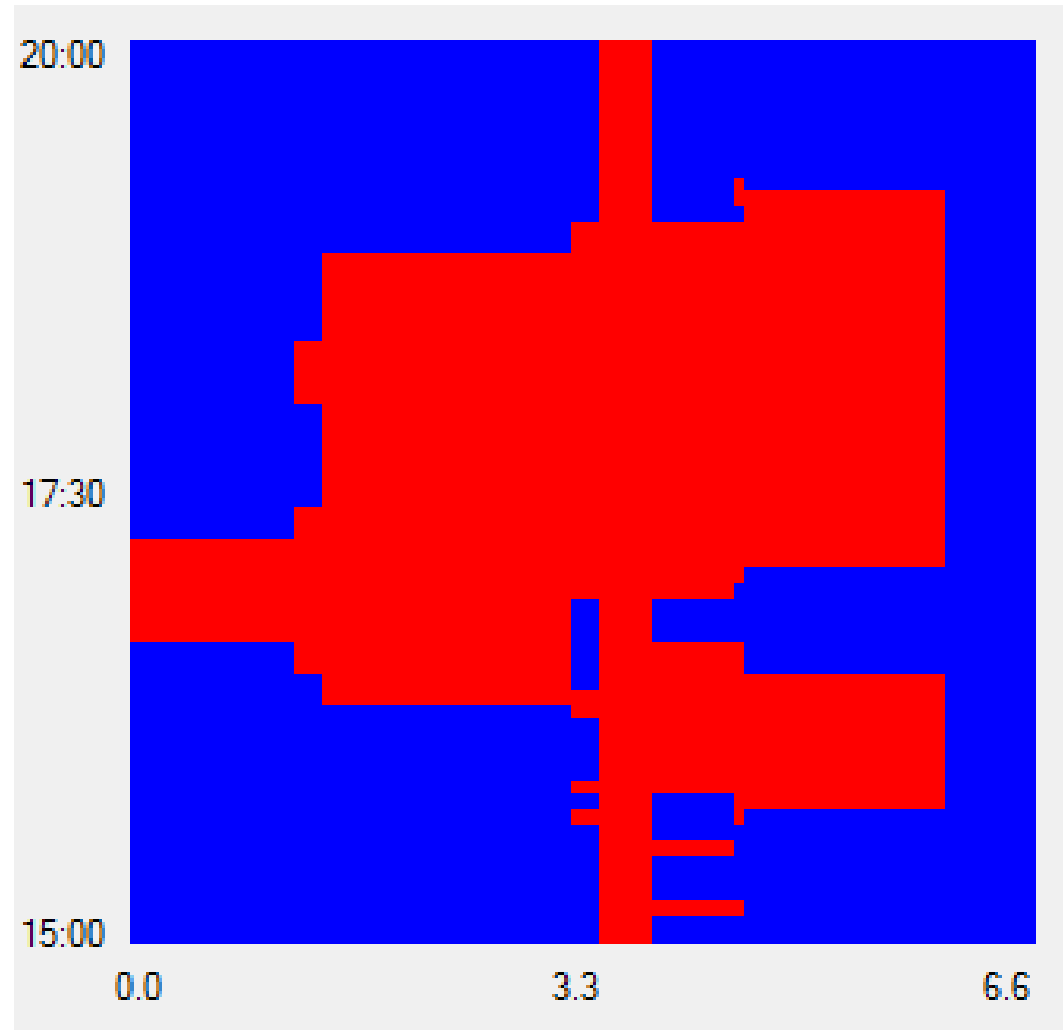


Source: HCM 2010

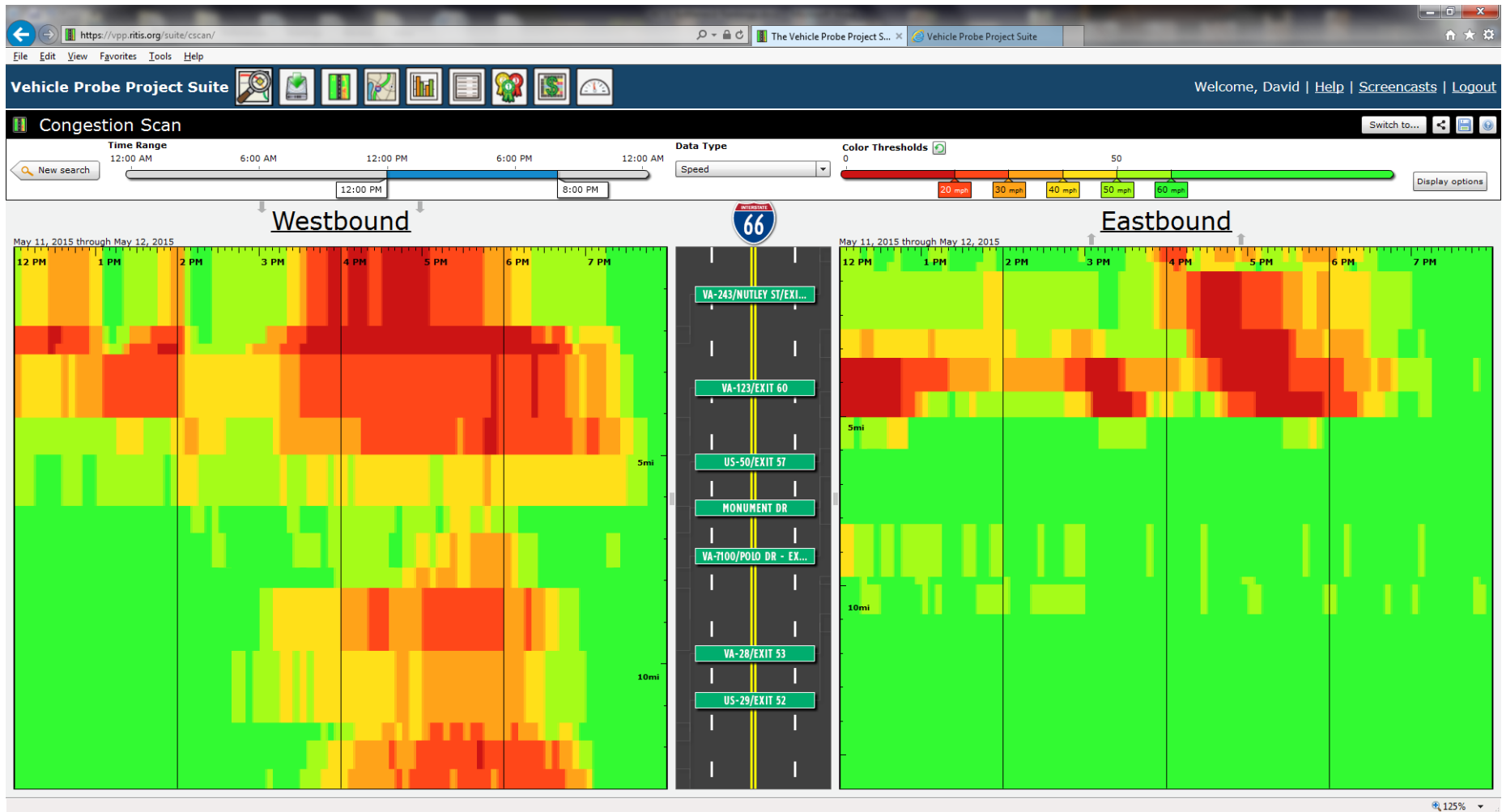
Bottleneck Intensity



- Criteria
 - Speed
 - Travel time
 - % Stops
- Bottleneck Intensity
 - Two-dimensional
 - Time and space
- Example
 - Define cutoff speeds
 - 43% of the box is red
 - Intensity = 43%



RITIS Congestion Identification

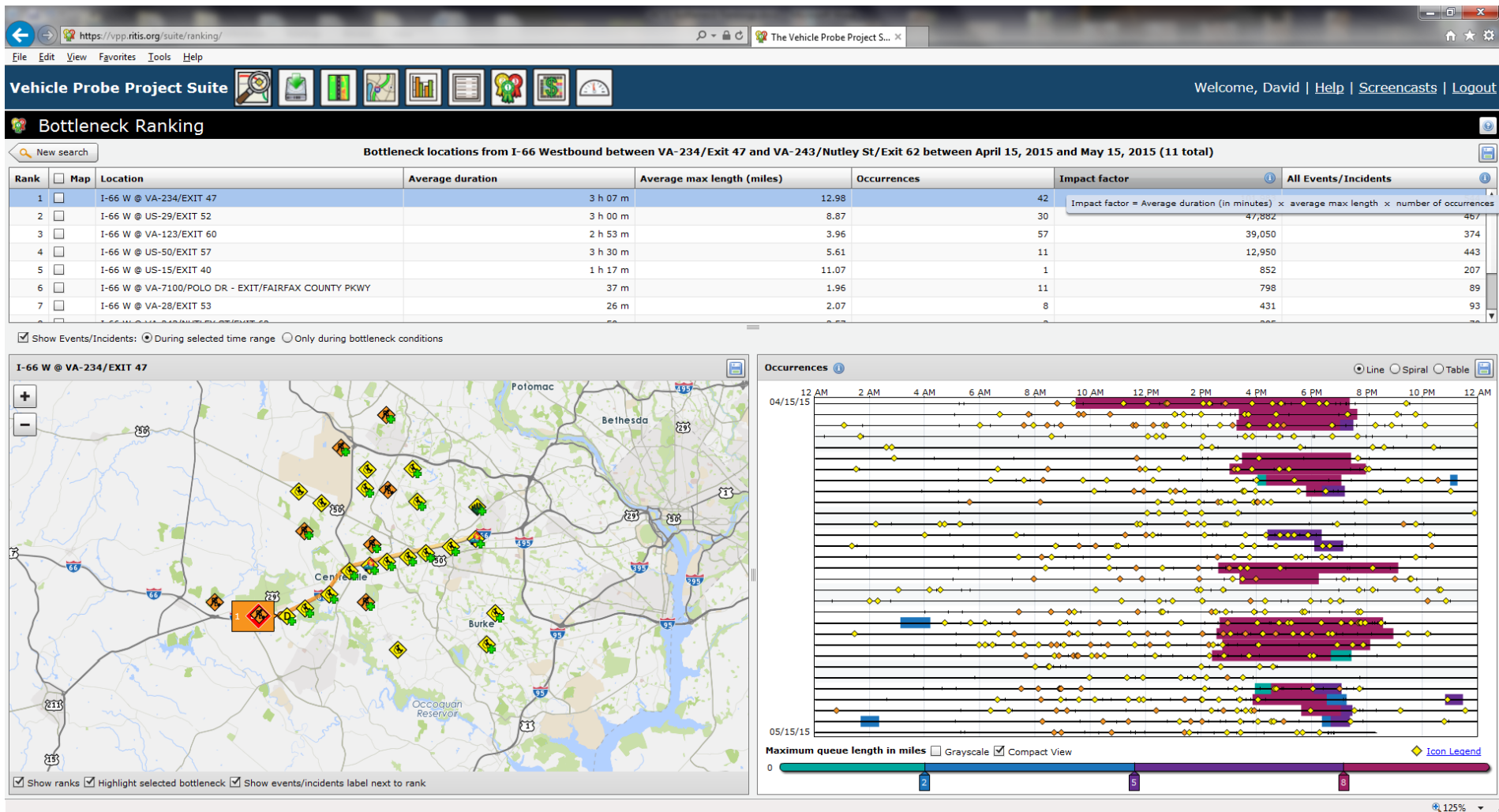


<https://vpp.ritis.org/suite>

RITIS Bottleneck Rankings



Impact factor = Average duration (in minutes) * average max length * number of occurrences



Congestion and Bottleneck Identification (beta version)

Data Import Filters

Direction NORTHBOUND

Universal Filters (Graphical and Numeric)

Free-Flow Speed

N/A

 From File

Cut-Off Speed

70 %

Hours

<input type="checkbox"/> 12 am	<input type="checkbox"/> 4 am	<input type="checkbox"/> 8 am	<input type="checkbox"/> 12 pm	<input checked="" type="checkbox"/> 4 pm	<input type="checkbox"/> 8 pm
<input type="checkbox"/> 1 am	<input type="checkbox"/> 5 am	<input type="checkbox"/> 9 am	<input type="checkbox"/> 1 pm	<input checked="" type="checkbox"/> 5 pm	<input type="checkbox"/> 9 pm
<input type="checkbox"/> 2 am	<input type="checkbox"/> 6 am	<input type="checkbox"/> 10 am	<input checked="" type="checkbox"/> 2 pm	<input checked="" type="checkbox"/> 6 pm	<input type="checkbox"/> 10 pm
<input type="checkbox"/> 3 am	<input type="checkbox"/> 7 am	<input type="checkbox"/> 11 am	<input checked="" type="checkbox"/> 3 pm	<input checked="" type="checkbox"/> 7 pm	<input type="checkbox"/> 11 pm

Mode Bottleneck ☐ Cutoff Model

Spatiotemporal Matrix Graphical Display Filters

Date 2014-09-22 ☒ Gridlines ☒ Labels ☐ Hotspots

Numeric Performance Measure Filters

Period Daily

Centile 85th Intensity

Months

<input type="checkbox"/> Jan	<input checked="" type="checkbox"/> Apr	<input checked="" type="checkbox"/> Jul	<input checked="" type="checkbox"/> Oct
<input type="checkbox"/> Feb	<input checked="" type="checkbox"/> May	<input checked="" type="checkbox"/> Aug	<input checked="" type="checkbox"/> Nov
<input checked="" type="checkbox"/> Mar	<input checked="" type="checkbox"/> Jun	<input checked="" type="checkbox"/> Sep	<input checked="" type="checkbox"/> Dec

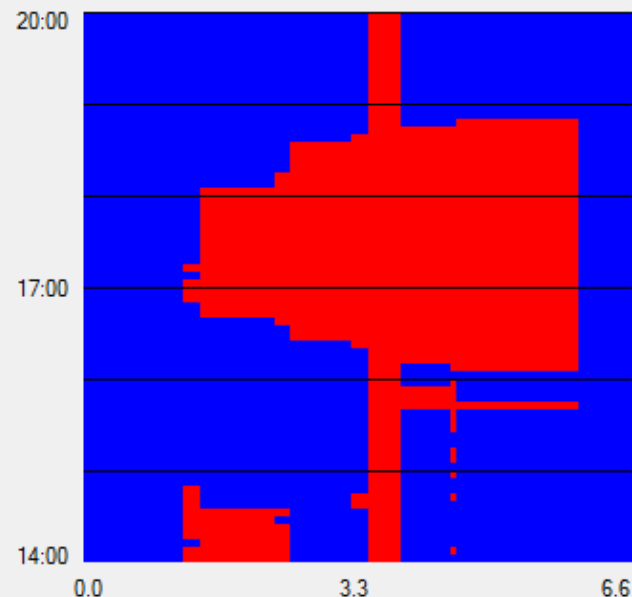
Data Files

Main C:\Users\halek1\Desktop\My Research\Bottlenecks\INRIX Datasets\I-895-seven-miles\I-895-seven-miles.csv

TMC C:\Users\halek1\Desktop\My Research\Bottlenecks\INRIX Datasets\I-895-seven-miles\TMC_Identification.csv

Import Data

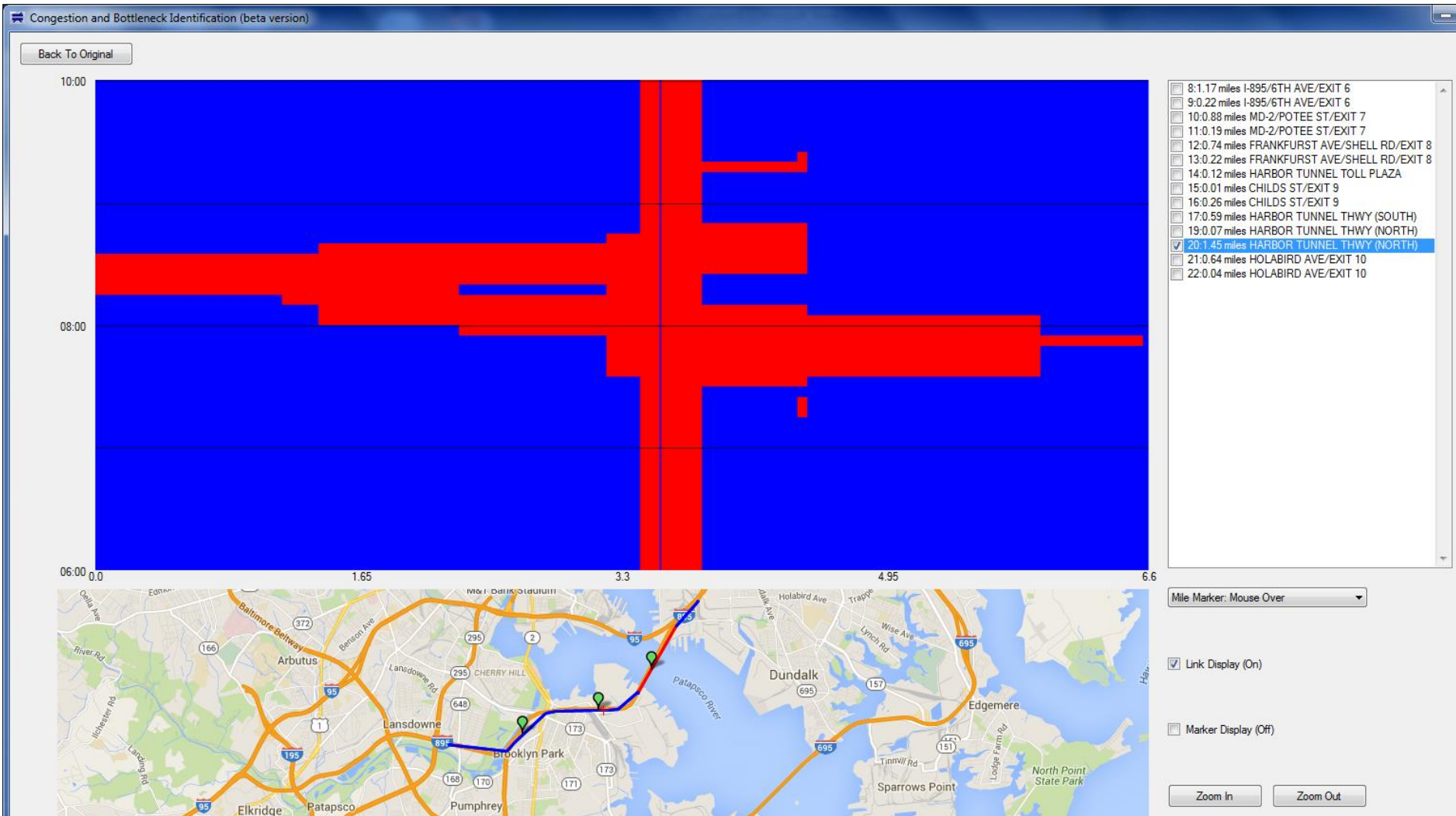
Successfully imported 954556 records



Numeric Performance Measures

Duration	360 minutes	Speed Drop	11.6%
Intensity	32.5%	BN Volume	3600 veh/h
Variability	N/A	Vehicle Delay	797 veh-hrs
Extent	2.4 miles	Max Delay	10000 veh-hrs

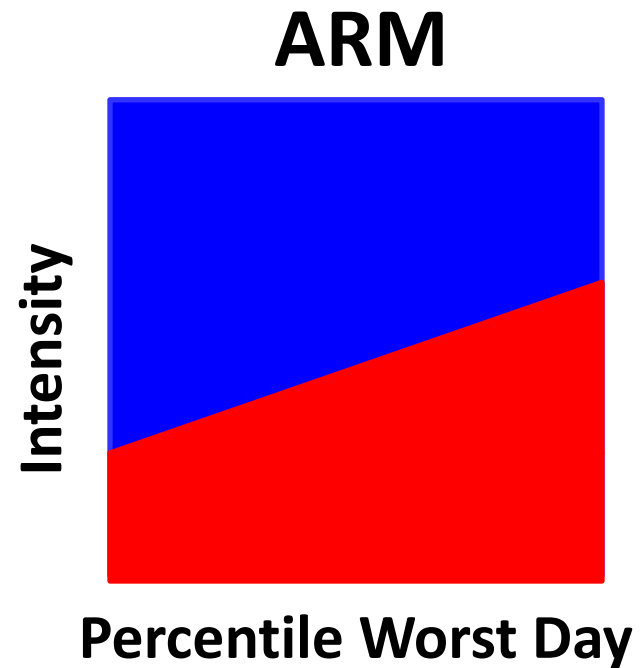
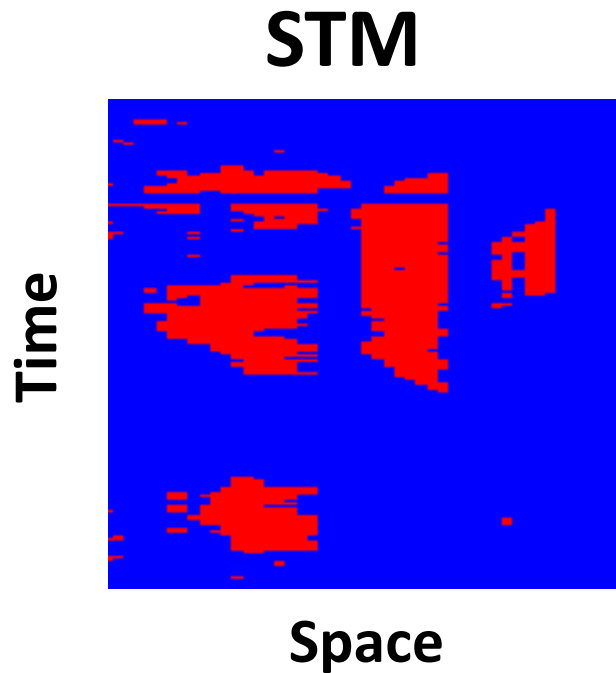
Google Map Feature



STM Versus ARM



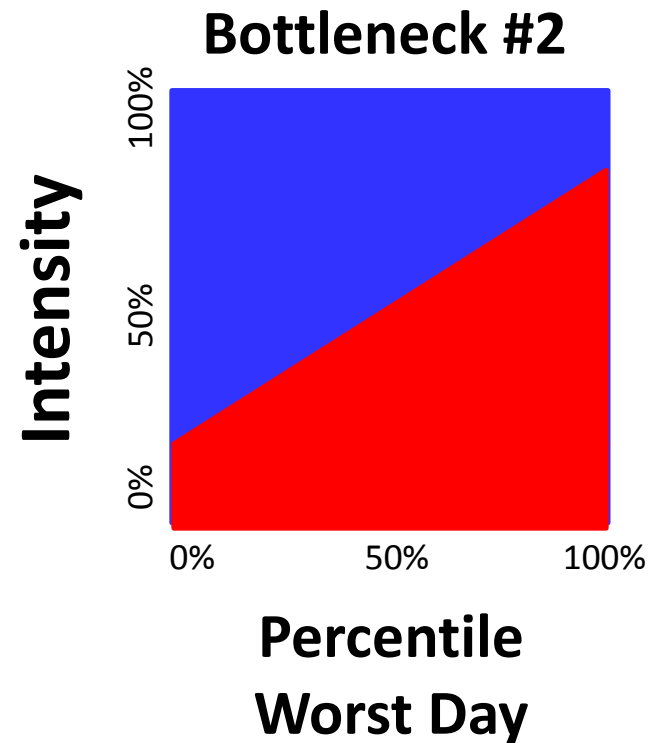
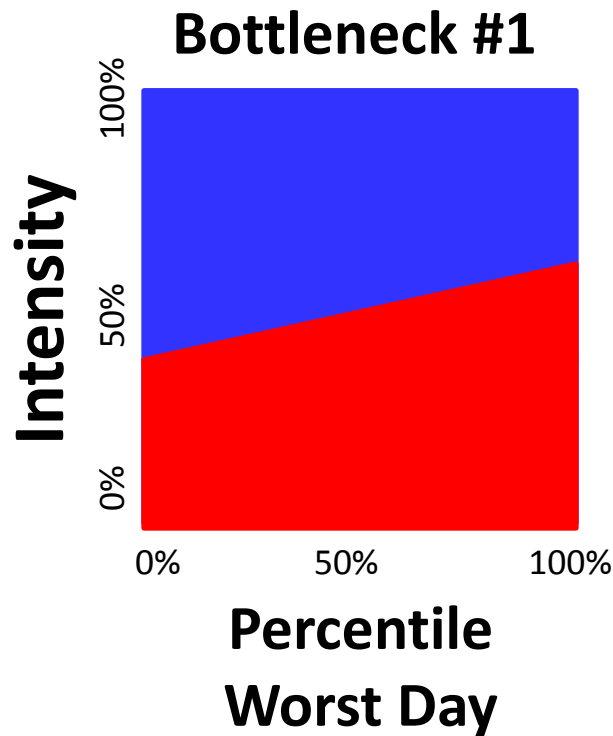
- STM (Spatiotemporal Traffic State Matrix)
- ARM (Annual Reliability Matrix)



Comparing ARMs



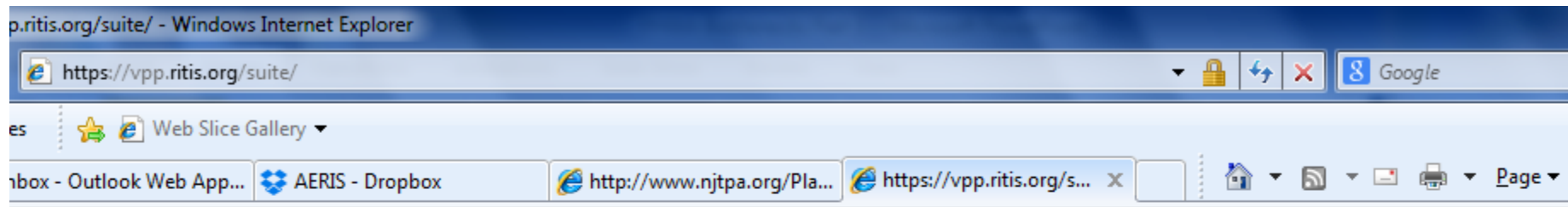
- Bottleneck #2 is a bigger problem
- More time needed to ensure on-time arrival



Software Tool Overview



- Downloading INRIX files from RITIS
 - Readings.csv
 - TMC_Identification.csv
- <https://vpp.ritis.org/suite/download/>



Sign in to your RITIS account

Email address

Password

The Vehicle Probe Project Suite



Access to the Vehicle Probe Project Suite is linked to your [RITIS](#) account. If you do not have a [RITIS](#) account, you can request one [here](#).

In addition, only members of public sector agencies that have signed the [Vehicle Probe Data Use Agreement](#) will be granted access to the Vehicle Probe Project Suite.

Software Tool Overview



2. Date Range

01/01/2014 - 12/31/2014

+ Add another date range

3. Days of week

Sun Mon Tue Wed Thu Fri Sat

4. Time of day

12 : 00 AM -to- 11 : 59 PM

+ Add another time of day

5. Fields

☒ Speed ☐ Historic average speed ☒ Reference speed
☐ Travel time ☐ Confidence score ☐ C-Value

6. Averaging

☐ Don't average ☒ 5 minutes ☐ 10 minutes
☐ 15 minutes ☐ 30 minutes ☐ 1 hour

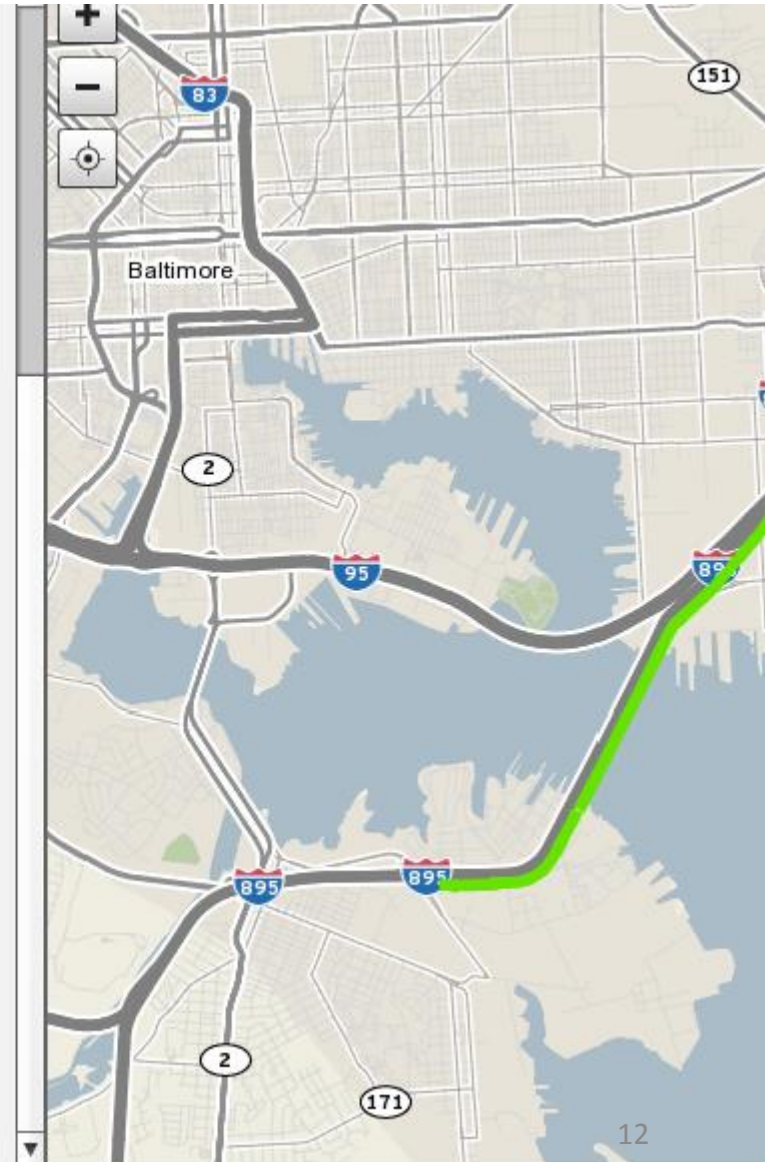
7. Description

Northbound I-895

8. Notification

☒ Send me an email when this export is ready

Submit download request



Software Tool Demo



[Play demo](#)

Ranking Freeway Bottlenecks



- Annual intensity and reliability
 - Bottleneck Intensity Index (BII), Speed Drop (SD)

I-695

BII 52%

SD 33%

I-495

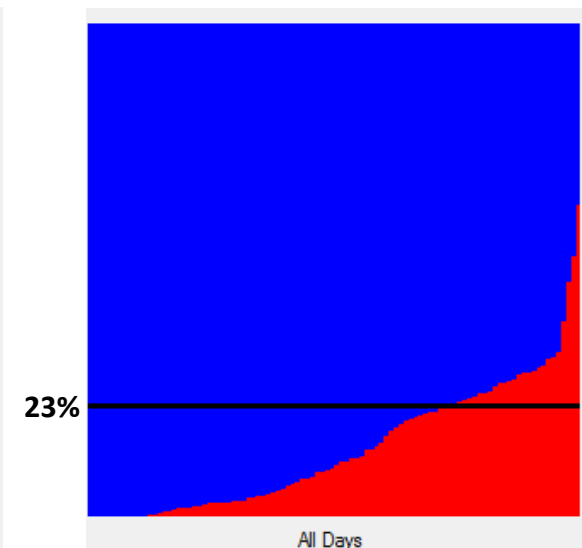
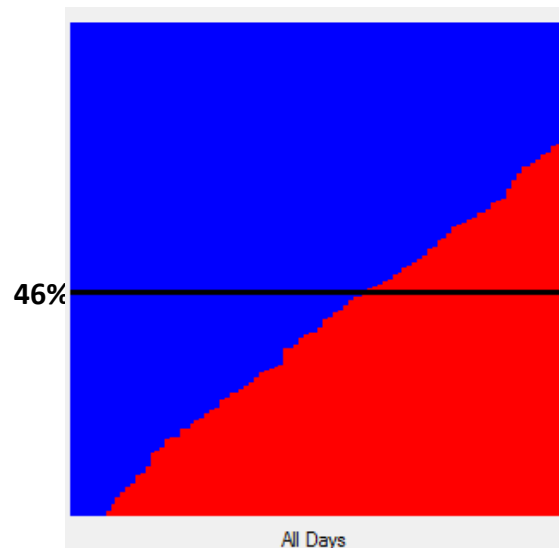
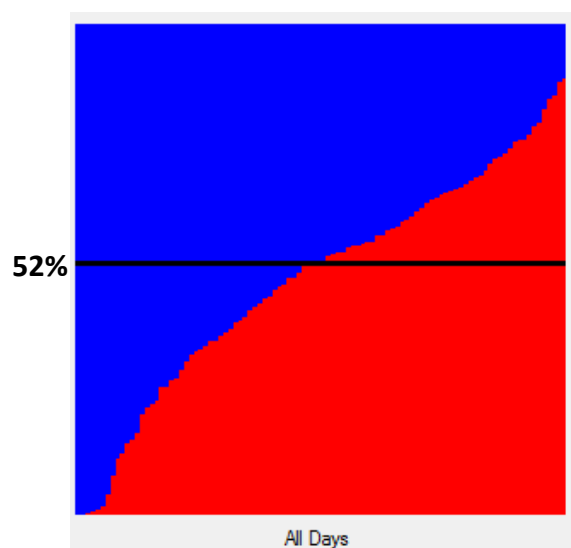
BII 46%

SD 17%

I-895

BII 23%

SD 11%

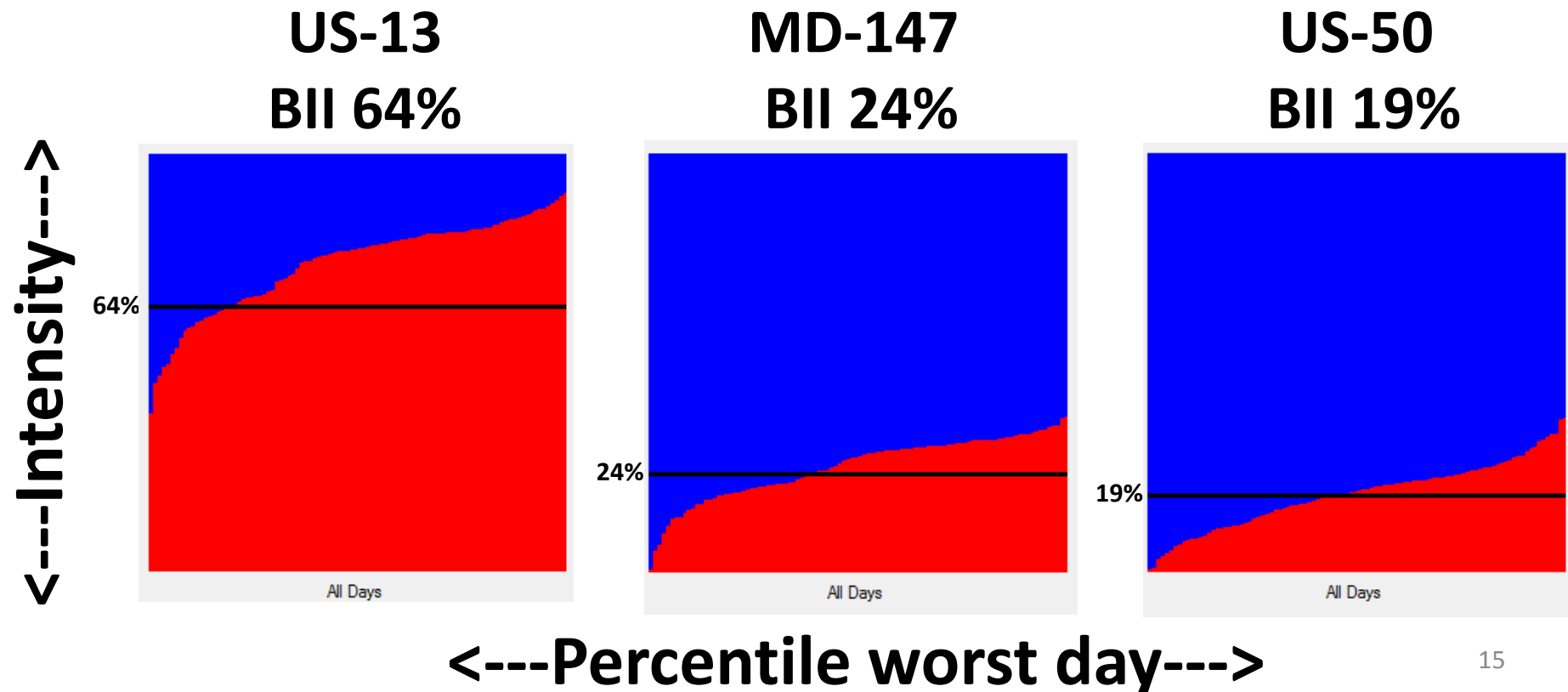


<---Percentile worst day--->

Ranking Arterial Bottlenecks



- Some delay caused by signals (not congestion)
- Lower accuracy of INRIX data on arterials
- Wavelet model might help



Wavelet Method Example



- PM Peak (4:30 PM – 5:30 PM), 6 TMC segments
- Default cutoff speed: 25 mph
- Adjust based on 0th percentile day
- If max speed < cutoff speed, reset cutoff speed
- This filters out “unavoidable delay”

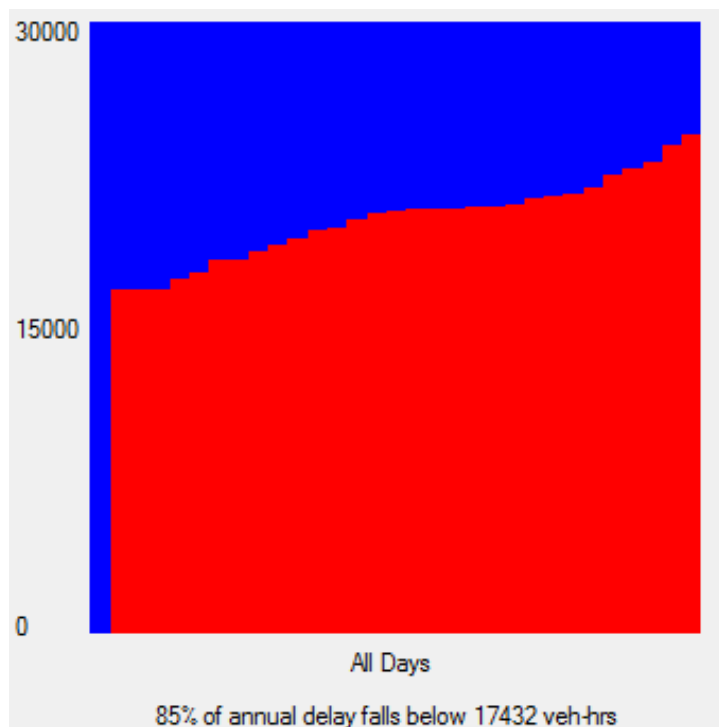
0th Percentile Day Speeds

	Seg. 1	Seg. 2	Seg. 3	Seg. 4	Seg. 5	Seg. 6
4:30	26	27	20	21	20	25
4:45	28	25	24	19	22	25
5:00	30	23	22	19	24	23
5:15	28	25	22	17	22	27
	25 mph	25 mph	24 mph	21 mph	24 mph	25 mph

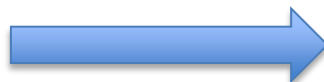
Wavelet Method Example



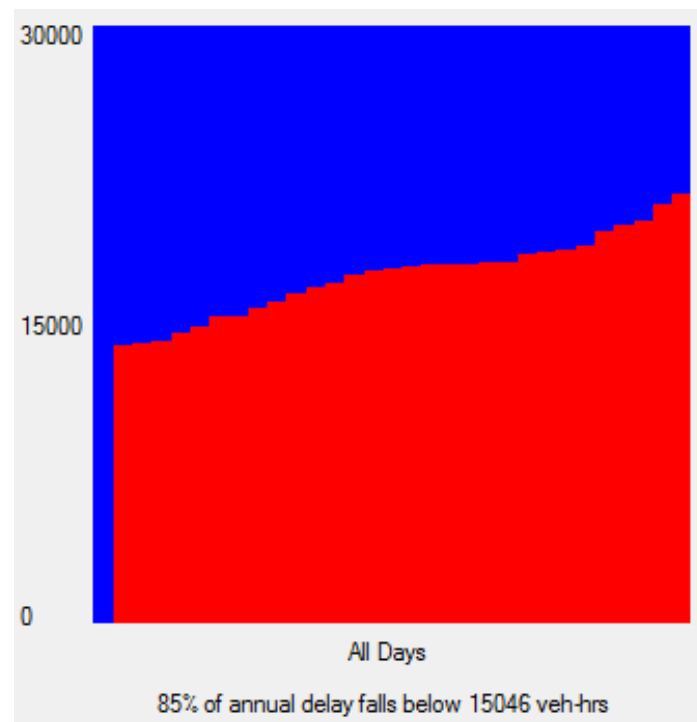
17432 veh-hrs



Filtering



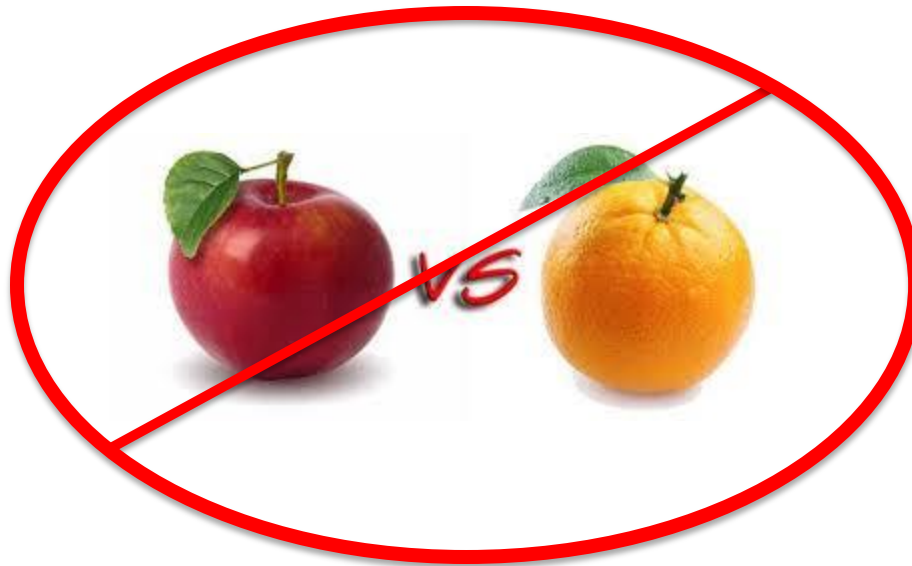
**15046 veh-hrs
(13.7% reduction)**



Ranking Bottlenecks



- When comparing different INRIX datasets...
- They should have the same
 - Interval duration (e.g., 5-minute)
 - Corridor length (sum of all segments)
 - Hours of day, days of week, months of year



Summary of Innovations



Unaddressed Issue	Innovation	Expected Benefit
Cutoff Speed	CBI Interface	weather, visibility, etc.
Variability	ARM	illustrates reliability
Numeric Index	BII	quantifies the ARM
Throughput	California	prioritizes congested roads
Signal Delay	Wavelet	reveals unavoidable delay

Summary



- Precise assessment of bottlenecks
- Demonstrate transportation improvements
- Justify transportation investments
- Prioritize problem areas

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